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GENERAL SCIENCE.—*The distribution of scientific information in the United States.*[1] ROBERT B. SOSMAN, Geophysical Laboratory, Carnegie Institution of Washington.

Of making many books there is no end.—ECCLESIASTES xii, 12.
But easy writing's curst hard reading.—SHERIDAN, *Clio's Protest.*

My two texts represent only two facets of a many-sided subject, about which much has been written and on which many opinions have been held. In this brief address I can hope only to sketch an outline of the subject as it appears from the standpoint of the scientific investigator, and illustrate the sketch with a few data drawn from observation and experiment.

For a subject so much more closely allied to applied sociology than to philosophy or "natural science," I cannot do better than make use of that excellent outline for any sociological discussion made familiar to the public by Professor Irving Fisher.[2] Any sociological problem may be considered under the following four heads: (I) What is it? (II) Why is it? (III) What of it? (IV) What are you going to do about it?

I. THE PROBLEM OF DISTRIBUTION

It was much in fashion before 1914 to argue about the relative merits of different systems of *production*. Most of our interest seemed to be directed toward the problem of producing commodities for human needs, and relatively little to the problem of distributing

[1] Address of the retiring president, Philosophical Society of Washington, presented at the meeting on January 15, 1921. Received January 22, 1921.

[2] *American problems of reconstruction* (New York, 1919), p. 362.

those commodities when produced. It required the stress of war conditions in 1917 and 1918 to wake us up to the fact that production was far better organized than distribution. It was not the factories and mines and farms that had to be taken over and unified under government control to meet war emergencies, but the railroads, steamship lines, export organizations, and wholesale and retail agencies of *distribution*.

An analogous situation has existed in the field of research for new knowledge. Private funds are expended in elaborate investigations; university laboratories and personnel are devoted to research on every conceivable subject; great foundations are established to carry forward systematized inquiry into problems too extensive for individuals to handle; and State and Federal governments devote large annual appropriations to obtaining new and useful knowledge through experiment and observation. Of what use is all this effort, unless its results be made available so that the public may benefit, intellectually or materially?

Yet the distribution of all this information is, relatively speaking, neglected, and left to the uncertain channels of the untutored private author, the unsympathetic clerk, or the sensation-seeking news agency. Much of it practically disappears from view soon after its discovery.

Let me emphasize this statement of the situation by a concrete example, taken from an informal communication by Mr. R. W. Stone[3] before the Geological Society of Washington in November, 1917.

About the year 1902 representatives of the Geological Survey of the State of Washington observed that the rock in a certain "marble" quarry consisted almost entirely of crystalline magnesium carbonate. Similar rocks were at the same time shown to exist at other localities in the State. The chemical analyses and other facts were published by the State Survey. Meanwhile the "marble" proved to be not a success as a building or decorative stone and the original quarry was abandoned and grew up in weeds.

Then came the World War, and by 1917 Austrian magnesite, which had until then been delivered on the Atlantic coast for the eastern steel works, was completely cut off. A massive magnesite from California then began to be shipped east. Chemical analyses showing that a better magnesite existed in Washington slumbered

[3] This JOURNAL 8: 99. 1918.

on the shelves. Meanwhile there came into the story a wandering lumber-cruiser, who happened to pick up a piece of the "marble" in the weed-grown quarry, and showed it to an official of a pulp company, who gave it to his chemist. The chemist reported that it was nearly pure $MgCO_3$. The official promptly bought the quarry for a nominal sum, resigned from the pulp company, and in a few months was shipping several hundred tons of magnesite per day, at about forty dollars per ton, to Ohio and Pennsylvania steel companies.

The *producers* of the original information did their task well; its *distributors* did theirs so poorly that the product never reached its ultimate *consumer*, the average citizen of the United States, in the crisis when he most needed it, and he had to fall back upon its rediscovery through the chance curiosity of a wandering lumberjack who had never read a geological bulletin in his life.

Probably every one of you could provide a similar story from your own experience to illustrate *the futility of publication*. But why should anyone be so unaware of vital facts, in a land which is flowing with publications and in which nearly everyone can read? The consideration of this question brings us to our second heading:

II. THE CAUSES OF INEFFECTIVE DISTRIBUTION

In the case of that minority of the population which can not read, ignorance of the very existence of useful information is sufficient to account for its failure to be distributed. This obvious cause needs no analysis.

The case that requires looking into is the case of that large proportion of the population which can read, if it will. The present ineffective distribution of information to this part of the population may be traced to two causes: (1) *disinclination* to use the knowledge we possess; (2) *inaccessibility* of the information when it is desired.

It is a familiar fact that the first reaction of the average individual to a new situation which contains elements of danger is to "hope for the best." This is true over the whole range of incidents from a "common cold" to those sources of international friction which result in wars. Scientific information—which means simply the systematized results of experiment and observation—is available as a guide to action in most of these situations, but we quite often proceed as if no human beings had ever had to grapple with such a problem before, or as if no record existed of the results of such

experiences. One philosopher, experienced in research, administration, and politics, refers to this lamentable fact as "the law of the conservation of ignorance."[4] Perhaps this law is only a natural inheritance from our happy-go-lucky simian ancestors;[5] but I gladly leave that problem to the anthropologists, psychologists, and psychoanalysts, and turn to the second cause of ineffective distribution, one which comes much more within the ken of a physical scientist.

THE INACCESSIBILITY OF SCIENTIFIC INFORMATION

It might seem that in a land so full of newspapers, periodicals, books, reading rooms, libraries, museums, lecture halls, and "movie" theaters, one could not properly speak of the "inaccessibility" of published information. But this very abundance is the first of three important causes that make any particular item of information quite inaccessible. A second cause is found in the extremely heterogeneous character of the product. And a third is the physical inability of some of our methods to connect producer and consumer, as will appear from a quantitative analysis of the situation.

In looking into this matter in more detail, I wish first to separate our complicated modern methods of distributing information into their "pure components," in order to see in what respects each one fails, or is likely to fail, in effectiveness.

But let it first be clearly understood that we are discussing the distribution of *information*, not *advice*. To illustrate: in the field of human physiology and pathology it is our custom seldom to ask the physician for information, but to expect only advice, that is, recommendations as to what to do next. To be sure, advice is what we usually need, and its distribution will always be a more necessary and a much larger industry than the distribution of information; but it is too big a subject to receive more than this passing mention here.

Under the term "scientific information" I shall include all systematized knowledge, gained by laboratory experiment, by observation of natural phenomena, or by the bringing together of old facts in new and significant combinations. Let us consider the channels by which this information is conveyed from its discoverer or assembler (the producer) to other individuals or to the public at large (the consumers). Five important channels may be distinguished:

[4] Carnegie Institution of Washington, Year Book 15: 14. 1916.

[5] CLARENCE DAY, JR. *This simian world.* (New York, 1920.)

(1) personal communication, (2) the public lecture, (3) the museum or exhibition, (4) the printed page, (5) the "movie" film.

We shall also bear in mind that for our present purposes a fairly sharp division can be drawn between two classes of consumers. The one, relatively small in numbers, consists of those who themselves are also producers of information, while the other consists of the greater part of the country's population.

Distribution by personal communication.—Undoubtedly the most effective method of distributing information, as far as the individual is concerned, is by personal communication. Anyone who has tried it knows that to discuss an unfamiliar subject with a specialist in that subject for an hour or two is equivalent to reading about it for a week.

Unfortunately, this method, the most effective of all as regards the individual, is the least effective of all as far as the public is concerned. The actual producers of scientific information in the United States form a very small fraction of the population. Those who devote all or part of their time to this pursuit can hardly number more than 50,000. If, then, every person in the country went to an original source only once a year for information, each producer would have to talk with 2120 inquirers per year, or about 7 persons per day on every one of 300 working days. Needless to say, production of new information would practically cease under such circumstances.

This interference of distribution with production, which I have just hinted at, is more serious than we are accustomed to consider it, for though every inhabitant of the United States does not seek original information even once a year, there are many inhabitants who seek it much oftener than that. Industrial concerns, with whom reliable new information is often a matter of success or failure, realize the value of personal contact and do not hesitate to send representatives on long journeys and pay their expenses for considerable periods, in order to get into personal touch with original sources. The public or quasi-public investigator also realizes it, sometimes to his sorrow. There is frequent complaint from members of the Government scientific bureaus that their time is seriously broken up by requests for information, in person, by telephone, or by letter. As one member of an active research organization expressed it, "I wish they would give me either the job of supplying information or the job of doing research; I cannot attempt both at once without spoiling them both."

The distribution of information to fellow-producers by this method, in exchange for similar information from their experience, is, however, one of the most important factors in the production of new knowledge, and is to be sharply distinguished from "unproductive" distribution to the public.

The informational middleman.—We have seen that the public as a whole cannot have access to the original sources, either in person or by mail. This kind of situation has been met in the commercial world since time immemorial through the aid of the middleman,—broker, commission merchant, wholesaler, retailer. Most of these agencies perform a useful service, which must be paid for, as organizers of cooperative distribution frequently find to their cost. Although the distribution of information is not as elaborately organized, its agencies are quite analogous to those used in commerce. Two types are to be distinguished, however: first, those which distribute information freely or at a nominal fee; and, second, those which distribute it for profit.

To the first class belong the information offices of the larger governmental bureaus, standing between the investigator and the public. A particularly effective example of this type is constituted by the "demonstration agents" of the Department of Agriculture and the State agricultural colleges. In 1919, 1200 "county agents" in the northern and western states conducted over 90,000 demonstrations reaching 1 million people, besides distributing information personally to individuals in various other ways. Other examples of the philanthropic type are the Research Information Service of the National Research Council, which aims to bring investigators into touch with each other; and the informational staffs of our public libraries.

In the second class, those operated for profit, the agencies distributing commercial and financial information are much further advanced in organization than those concerned with the physical and natural sciences. Babson's financial and investment service is a type in the field of economics. The corresponding function for chemistry, physics, geology, and related sciences is usually still handled as a part of the work of the consulting engineer, although in certain establishments like that of Arthur D. Little, Inc., this part of the work is given an important position and dignified with offices and records of its own. It is also a growing custom for manufacturers to employ representatives in Washington to keep them in touch with the Federal bureaus.

In the field of human physiology and pathology, as before remarked, the sale of information is distinctly a minor matter compared with the sale of advice.[6] This case serves very well to illustrate another restriction on the distribution of information for profit, namely, that the information is frequently a part of the working capital and equipment of the middleman (physician, consulting engineer, etc.), and if sold should bring a much higher price than advice. We should logically and reasonably expect to pay at least twenty times as much for the one as for the other.

To summarize: The method of personal communication of information, direct or through the middleman, is effective enough as between producers; but is usually quite ineffective with respect to the public simply from physical inaccessibility, except in certain cases where it has been organized on a considerable scale for the definite purpose of distributing certain kinds of information.

Distribution by public lectures.—It is probable that men have always assembled together for the purpose of being harangued, exhorted, or entertained by one of their number, but their assembly to receive information from a speaker or reader seems a development of modern civilization. Even now, there are relatively few human beings who can be induced to sit still for more than a few minutes to hear facts stated or theories expounded, even when it is done with skill and in an interesting way. Such folk are mostly to be found in scientific or cultural societies, yet even in this limited circle I have observed (at a general meeting of the American Association, for example) that there are often more members in the lobby than there are listening to the papers.

All this is merely an expression, I suppose, of the fact that although the ear is a very much better physical instrument than the eye, impressions received through spoken words have only a fraction of the clearness of impressions received through the sense of sight.

As before, we may distinguish between philanthropic lecturing and lecturing for profit. The comparative rarity of the latter in its pure form is perhaps an indication of the method's essential ineffectiveness, to which reference has already been made. It is seldom if ever used commercially without the assistance of some oth r appeal, such as moving pictures or the attraction of getting a personal view of some celebrity.

[6] In this field we have the condition, anomalous in a community whose form of government is based upon the assumption of an intelligent and informed public, that the sale of certain kinds of information is forbidden by law.

Philanthropic lecturing is done almost entirely through the medium of scientific or technical societies, which have now become very numerous. Washington alone possesses 35 or more.[7] The distribution of information by lecturers is also a secondary activity of many social organizations. Finally there should be mentioned its use, admittedly rather ineffective, in college and university instruction. Altogether, assuming that there are annually in the District of Columbia 300 meetings of scientific societies, 500 lectures before social organizations, and 3000 lectures in our 8 universities and colleges, with an attendance of 50 persons at each, a public informational lecture reaches a given individual in the District on an average once in every 2.4 years. And Washington is undoubtedly ahead of most American cities in this respect.

To summarize: The public lecture is largely used for the distribution of information among producers of information, in which function its effectiveness, though not small, is limited more by the heterogeneous character of the output than by any other factor. It is very ineffective with respect to the public, not so much from physical inaccessibility as from the limitations set upon it by the laws of psychology.

Museums and exhibitions.—Next in logical order after methods of personal communication and public announcement should be placed methods depending on the exhibition for public study of objects, specimens, models, etc. Although the temporary "exhibition" or "exposition" and the permanent museum both have a function as distributors of information, they can be traced to rather different origins; the exhibition, to the market or "fair," designed to bring together buyers and sellers of commodities; the museum, to the ecclesiastical or imperial collection of objects of art, trophies, and "curiosities," which collections later became the property of the public and were devoted to purposes of public instruction.

The evolution of the modern scientific museum has been particularly rapid. It has been hardly fifty years since the museum began to be looked upon as something more than a repository for the specimens collected by explorers and a place for the study and comparison of natural objects by specialists, and as offering tremendous possibilities for the diffusion of knowledge. As compared with its predecessors, the museum of today stresses the verb "diffuse" much more than "collect."

[7] *Directory of the Washington Academy of Sciences and its affiliated societies*, 1921 edition.

There is a curious psychical limitation on the effectiveness of the museum, arising from the feeling on the part of many that a museum is a place where dusty and cob-webbed curios have lain on shelves for years; a place which one visits once in his lifetime, while "traveling." The population of the District of Columbia is a little over 0.4 million. During the twelve months ending with June 1920 practically this number of people visited the main building of the National Museum, and it is probable that the most of these were tourists or travelers. Yet in the same period the National Zoological Park, containing much that is interesting but little that is usefully instructive, entertained over 2.2 million visitors.

The arithmetical limitation on the effectiveness of a museum may be seen from the fact that if every city in the United States having 10,000 or more inhabitants possessed a museum, and if a given object in each were examined for two minutes by each one of a constant stream of visitors passing all through a 7-hour day every day in the year, then every person in the United States would have such an opportunity for instruction once every three years.

The psychical disinclination to make real use of a museum is absent in the case of the "exhibition," "exposition" or "fair," which is available only for a short time and must be taken advantage of at once or not at all. The commercial world has made use of this medium of distributing information to a much greater extent than the scientific world, but its possibilities are well illustrated on the small scale by the success of such expositions as that held a few years ago by the Washington Academy of Sciences, and by the exhibition of the wireless telephone held in Washington last year by the National Research Council and the American Telephone and Telegraph Company; and on the large scale by the National Exposition of Chemical Industries in New York, which instructed over 0.1 million people during its few days of activity last September.

To summarize: The museum and exhibition are more efficiently utilized by the public than by the investigator. It is probable that comparatively little new knowledge is distributed to its producers by this channel. The method is physically unable, however, to reach the whole public effectively; but it is, of all the means of distribution, the one most capable of neutralizing, by systematic and correlated exhibits, the disadvantage of heterogeneity.

Distribution by the printed page.—The changed circumstances of the world that followed from the invention of printing, and especially

from the invention of the chemical and mechanical processes for the manufacture of wood-pulp, need not be gone into here. Social philosophers alternately approve and lament the change. It is plain that we are almost literally carried along on a stream of wood-pulp. The country's activities are nearly as dependent on a constant supply of printing and writing paper as upon constant supplies of coal and iron. About 3.4 million metric tons of printing and writing paper were manufactured in the United States in 1918, or 29 kg. for each individual. It will be of interest to inquire how much of this was used for the distribution of scientific information, and how effectively.

Books.—Of all the means of distribution by printing, that by books is intrinsically the most effective. The term "book" is a little difficult to limit, but I include under the term any publication in which one subject or group of subjects is treated in a single unit, with some attempt at completeness or comprehensiveness. This would include, for example, some of the bulletins of the Federal and State geological surveys, but not all.

Most scientific and technical books are published for profit. The output in this class in the United States in 1920 I estimate at about 1900 works including new editions.[8] If we assume that the average number of each printed was 1000, the total would be about equivalent to one volume to each 55 individuals of the population per year. Their effectiveness is not represented by this figure, however, because the use of each is considerably multiplied by the existence of public libraries; fairly exact quantitative data on this point might be obtained by the study of existing library statistics.

A second group comprises books which are made to pay the cost of their paper, printing and binding. Examples are the publications of the West Virginia Geological Survey, the Carnegie Institution of Washington, and some Federal bulletins. These are usually distributed free to libraries, and reach a much larger number through that medium than by direct sale.

A third group comprises books distributed free or at a purely nominal charge. This includes the greater part of the "book"-literature among the publications of the Federal bureaus and State experiment stations. These books likewise receive wide use through libraries, perhaps wider in certain cases than by direct free distribution.

[8] See also F. E. WOODWARD. *A graphic survey of book publication, 1890–1916.* Bur. Education Bull. 1917, No. 14.

Contrary to what might logically be expected, the efficiency of distribution of books made and sold for profit appears to be greater than that of books distributed free or at cost. The reason is perhaps that the life of the business, in the former case, is absolutely dependent on efficient advertising of the books produced. The carrying of an adequate stock to meet the demand is also necessary. On the other hand, institutions distributing books free or at cost do not always feel the necessity of advertising or of carrying stocks, or even of providing adequately for the prompt and business-like handling of requests. As to their use in libraries, my few observations lead me to believe that books are valued and cared for by librarians, just as by individuals, approximately in proportion to what it has cost to obtain them.

To summarize: As a means for the distribution of information among its producers, books are relatively effective, those published for profit rather more so than those published at cost or distributed free. For distribution to the public they are less effective, the disparity between profitable and philanthropic also being markedly greater; but they still probably exceed in present effectiveness any other form of printed matter. With respect to both classes of consumers, scientific books are not so numerous but that the desired information is reasonably accessible; and they serve the invaluable purpose of sifting and sorting the new knowledge as it comes out of the mill. But they are under the disadvantage of being from one to twenty years behind the times.

Scientific and technical periodicals and bulletins.—It is difficult to visualize the tremendous volume of printed matter which is daily made available to the reading public. The greater part of it consists of newspapers, general periodicals, and popular books, but even the small fraction of it which is devoted to science is impressive in its bulk. The American Chemical Society, for example, printed about 250 metric tons of reading matter during the year 1920. It distributed to each of its members 15.0 kilograms of chemical information, contained in about 8400 printed pages exclusive of advertising.

I might tell you, in the customary manner of statisticians, how many times these pages could be made to girdle the earth, except that such comparisons are about as meaningless as the original figures, since nobody has any concrete picture of the size of the earth. A much better realization is had of the bulk of this one year's chemistry if I point out how long it would take to read it aloud.

One can easily calculate that to read aloud at reasonable speed the publications of the American Chemical Society for 1920 would require about 514 hours, or 64 full working days of 8 hours each—over two months. After seeing these facts it is not difficult to believe the statement that no one individual can be fully informed as to the progress of chemistry in all its branches.

After thus getting a realizing sense of the overwhelming bulk of the Chemical Society's publications, let us recall that numerous other agencies also are publishing chemical information. Then add to this the volume of reading matter put forth by physicists, engineers, geologists, astronomers, and biological scientists of every variety, through the medium of publication agencies numbering in the scores for this country alone, and the "futility of publication" of which I gave an illustration at the beginning of this address becomes readily understandable.

Like all the other media of distribution which we have considered, this type must be divided into two classes, the philanthropic and the profitable.

In the philanthropic class belong the journals and proceedings of the scientific and technical societies, and the current bulletins of Federal and State bureaus, university laboratories, and museums. As a group the philanthropic periodicals are characterized by two features both of which are inimical to effective distribution: subdivision into a large number of independent units, and small circulation of each unit. There were listed[9] in the United States in 1920 about 240 strictly scientific and technological publications, not including such as might be more properly called "trade journals," of which there were about as many more. About 100 of those which I have classed as "scientific and technological" were medical periodicals. Apparently about one-fourth of the remainder (those devoted to "science and engineering" as ordinarily understood) were published for profit. The circulation of the philanthropic class varied from 75,000 for the *Journal of the American Medical Association* down to 175 for the *Journal of Entomology and Zoology* of Claremont, California, but the greater part of the scientific and technological group had a circulation of the order of magnitude of 500 to 800.

The Federal bureaus in Wash ngton publish about 75 different series of publications of a scientific or technological character, not counting

[9] *Ayer's American newspaper annual and directory.* (Philadelphia, 1921.) Evidently the list is far from complete. Probably no list approaching completeness is in existence, although one is now in course of compilation at the Smithsonian Institution.

maps and annual reports.[10] The size of the editions[11] varies from a few hundred to over a million, but most of them were of the order of magnitude of 1000 to 3000. The Department of Agriculture distributed a total of 62.2 million documents in 1918. I have no data at hand concerning bulletins of State bureaus, university bulletins, or the undoubtedly numerous publications not listed in Ayer's Annual, but their circulations are of the same order as for the scientific periodicals.

As I indicated at the beginning of this section by the example of the Chemical Society, the scientific-periodical type of printed matter is overwhelming in its bulk with reference to the producers of information, among whom it finds a large part of its circulation. At the same time, the extreme heterogeneity of the product and the extreme subdivision of its units of publication are its most outstanding characteristics. The result is a very ineffective distribution of the information even among its producers.

Praiseworthy efforts have been made to offset these disadvantages by means of abstracting periodicals, indexes, and guides. But so great is the bulk of material that even the indexes and guides themselves are lost in the stream.

So much for the producing class. With respect to the general public the philanthropic-scientific-periodical type of literature is an almost negligible channel of distribution. The usual circulation of a scientific periodical is about half a dozen copies per million inhabitants, a relatively minor ripple in the great current of woodpulp. Yet it is not quite as bad as it looks, thanks to the existence of abstracting periodicals and of public libraries. The more important results of a research published in the *Journal of Physical Chemistry*, for example, with a circulation of only a few hundred, are reproduced in *Chemical Abstracts*, which, by means of its circulation of over 15,000 and its appearance in every important library of the country, may place the data before many thousands of persons.[12]

The foregoing remarks concerning the bulk and heterogeneity of

[10] Estimated from data in W. I. SWANTON'S *Guide to United States Government publications*. Bur. Education Bull. 1918, No. 2. See also E. GUERRIER, *The Federal executive departments as sources of information for libraries*. Bur. Education Bull. 1919, No. 74.

[11] No published summarized data are available on this point. An act of 1895 limits the initial edition of any departmental publication to 1000. Special acts provide for special publications or particular bureaus. To supply large demands reprintings are permitted.

[12] During the War a Library Information Service was maintained in Washington to keep the librarians of the country in touch with Federal publications. Its future maintenance is dependent on the passage of a bill now before Congress (H. R. 6870 and S. 2457).

philanthropic periodicals apply equally well to those published for profit, but there are some special features of the latter which require further consideration.

The publication for profit of strictly technological periodicals (not trade journals) is a relatively recent development. The most conspicuous example is the group of journals published by the McGraw-Hill Company. They have the great advantage of being edited, managed, and circulated by men whose business is editing, managing and circulating periodicals, and nothing else. They do not suffer from the haphazard editing, inefficient business management, and almost neglected circulation characteristic of most scientific society journals. At first rather looked down upon and avoided by scientific investigators, this class of periodicals now obtains, by contribution, special reporting, or reprinting, first-class readable material which it puts into the hands of readers at a comparatively small price.

The scientific societies have apparently not become aware of the possibilities, both beneficent and dangerous, of these journals. It is most important to recognize that their profit does not come from subscriptions, but from *advertising*. Their problem, and likewise the problem they offer the community, is thus exactly the same as that of the popular magazine and the newspaper; they must publish just enough reading matter, of just high enough grade, to most efficiently carry the advertising, *and no more*. What this amount and grade of reading matter shall be seems now fairly well established for the newspaper, but is still a subject of empirical experimentation by the popular magazine and the technical periodical published for profit, with extinction as the penalty for the ones that make the poorest guess.

This dependence upon advertising may even have the effect of making it good policy to *restrict* the circulation in certain directions rather than enlarge it, and thus make the journal actually work against rather than for the widest distribution of the information it carries. The *American Machinist*, for example, probably costs in the neighborhood of twenty dollars per copy per year, yet it sells for $4.00 per year. Obviously, to send this journal to a professor of Latin, with no interest in and no buying power for machine tools, even though he be willing and eager to pay his $4.00 for it, is to waste $16.00, for the advertisers have no interest in supplying information to professors of Latin. This extreme case will serve to emphasize

the fact that it might even become unprofitable to send the *American Machinist* to any machinist but a master mechanic.

In this connection I may note an interesting experiment now being made by the American Chemical Society. Considering the possible profit from advertising as well as the desirability of serving its industrial members, the Society in 1909 founded the *Journal of Industrial and Engineering Chemistry*, which has advertising and business offices, and an editor who devotes all his time to the *Journal*. The profit from this journal in 1919 was such that the Society was enabled to do publishing and other work that would have required an increase in dues of $3.00 per year for its 15,500 members, had this aid not been available.

To summarize: Scientific and technological periodicals and bulletins reach the producers of information in overwhelming bulk. The extreme heterogeneity of the material and its subdivision into many units of publication combine with this bulk to make them relatively ineffective distributors of information even to the producing class. With respect to the general public, their small circulation makes them almost negligible as channels of distribution (with the possible exception of certain Federal bulletins of wide circulation), and public libraries can do little to offset this disadvantage, for the average library has not the facilities for handling them all. The type of periodical which is published for profit is affected in all these respects by its dependence upon advertising.

Separates.[13]—In an effort to prevent the complete drowning and submergence of their work in the general current, many investigators during the last half-century have adopted the plan of getting "reprints" of their published work, and distributing these by mail to persons whom they know to be interested in the subject. In recent years this method has even been adopted by some research institutions, such as the Geophysical Laboratory and the Mt. Wilson Observatory of the Carnegie Institution of Washington, and the Research Laboratory of Physical Chemistry at the Massachusetts Institute of Technology.[14] A few organizations carry stocks of separates for sale (*e.g.*, the Franklin Institute).

[13] Commonly (but incorrectly) called "reprints" in this country. A better term is "offprints" (separata, extraits. Sonderabdrücke).

[14] Separates from periodicals are occasionally used by the Federal bureaus; for example, separates from the *National Geographic Magazine* by the U. S. Reclamation Service. Separates from their own periodicals are also distributed; for example, from the *Journal of Agricultural Research* and the *Proceedings of the National Museum*.

The publication of scientific periodicals in the form of loose separates which can be filed according to the taste of the subscriber has been suggested several times, and an actual trial of the plan was begun by the American Institute of Mining and Metallurgical Engineers in 1920. It is still too soon to judge of the advantages or disadvantages of the plan. Somewhat similar is the loose-leaf type of serial literature best exemplified by *Lefax*.

Popular magazines.—There were listed[15] in 1920 in the United States and Canada 139 literary, illustrated, and humorous publications of general circulation, most of them issued monthly; 33 "women's publications of home circulation;" and 25 "mail order publications." In addition, there were 880 religious and 562 agricultural publications, mostly weekly. The aggregate circulation of the first group was about 22 million, and the individual circulation varied from 2.1 million down to 0.01 million. The aggregate circulation of all was of the order of magnitude of 80 million; which, taking into account the number of weekly publications, is very probably equivalent to at least two copies per month for every inhabitant of the country,—numerically a very effective medium of distribution.

The material published by these periodicals covers a wide range. A few are specifically devoted almost wholly to scientific information. Such are the *Popular Science Monthly*, *Science and Invention*, and *Scientific American Monthly*. Having circulations of 0.1 to 0.25 million, and appearing in all public libraries, this group reaches perhaps 2 million readers. The most striking example of success in this field, and one which proves the existence of an extensive public demand for information as well as for entertainment, is the *National Geographic Magazine* of this city, with nearly 0.8 million circulation.

Beginning with the scientific-informational type, these general periodicals may be arranged in order of decreasing amounts of information, ending with those made up entirely of fiction, fun, or gossip. As a whole, they supply a very large quantity of scientific information to the public, but the material is nearly as heterogeneous and disconnected as that supplied by the strictly scientific group.

With respect to producers of information, they play a very small part in distribution. Seldom, if ever, do they announce the original results of research. They are under the necessity not so much of making a correct and understandable record, as of making a readable and interesting record, of discoveries. Hence their dependence upon

[15] Ayer's Annual, 1921.

literary rather than scientific skill,—in other words, they must depend upon the middleman rather than the producer for their material.

To summarize: The general monthly and weekly periodicals are at present numerically the most effective agency for the distribution of scientific information to the public; bulk and heterogeneity, however, discount their effectiveness as compared with books. They are a negligible factor in distribution to producers of information.

Newspapers.—About 2400 daily newspapers were published in the United States in 1920, with a total circulation of about 31 million, or about one for every third person in the United States, *daily*. There were also published some 13,000 weekly papers. The possibilities for distributing information by this medium are thus tremendously greater than by any other of the methods we have considered.

In spite of this fact the newspaper has hardly been utilized at all for the distribution of information. Its contents are principally (1) advertising, (2) the news of the day, partly systematized, (3) repetitions and reiterations of that news in various forms, (4) opinions and predictions, (5) advice and propaganda, (6) fiction, (7) fun, and (8) gossip.[16] There are good reasons for the existence of all of these departments of the newspaper, and also for the absence of any considerable amount of real information. I shall not attempt to analyze these reasons, beyond remarking that the haste in which the newspaper is usually read is an important factor.

One factor which we should consider, though probably a minor one, has been the information-producer's distaste for newspaper publicity. The teacher and the investigator, as a class, have inherited certain disabilities from past centuries, chief among which is that of being looked upon as akin to the medicine-man, monk, astrologer, or wizard. This tradition demands of the newspaper that the products of scientific investigation shall be "played up" in a corresponding form and most scientists have studiously avoided that insult to their self-respect—not a wanton insult, be it understood, but one demanded by the circumstances, just as vituperation is called for in a political campaign.

Of recent years, the knowledge-producing profession has increased greatly in numbers, and has accordingly come more intimately into touch with the world's every-day work. There is resulting a change

[16] I would include under this term much material which would come under the dictionary's definition of "news," but which has not the remotest relation to the interests of a given reader.

in the attitude of the public and the newspapers. Serious efforts are now being made to increase distribution by way of the newspaper channel. One striking example is the geographical news service of the National Geographic Society of this city, which now reaches about 12 million people through its news bulletins. The American Chemical Society maintains a press service, with a salaried director, for the dissemination of accurate chemical information. Another experiment, about to be initiated, is being supported financially by Mr. W. E. Scripps. It consists of a "Science Service" for the newspapers, under the control of a board having a majority of scientific men who are nominated by the National Academy of Sciences, the American Association for the Advancement of Science, the National Research Council, and certain other organizations. Mr. E. E. Slosson, associate editor of *The Independent* and author of one of the best of the popular books on chemistry, has been appointed editor of the Service and will make his headquarters in Washington.

Another experiment, of considerable local interest, was initiated last Monday, January 10, by the *Washington Herald*, in placing a special column at the disposal of Mr. Watson Davis, a member of the staff of the Bureau of Standards who has had newspaper experience. The column contains announcements and brief reviews of the papers presented before the Washington Academy and the scientific and technical societies allied with it. It is a task requiring enthusiasm, persistence and conscientiousness, and I trust that the undertaking will meet with deserved success.

To summarize: The daily and weekly newspaper could become numerically the most efficient existing medium for reaching all the population, but has been very little used for the distribution of information in this country. The producers are too small a class to receive consideration, except in special localities such as Washington, while the general public has not been educated to demand the product through this channel.

Distribution by the cinematograph.—A decade ago we should have mentioned the moving picture as a useful adjunct to the public lecture. Today "film" is said to be the fifth or fourth industry of the country. The producers of film estimate that one person in every ten in the United States goes into a moving-picture house *daily*.[17] It is probably second only to the printed page in its effectiveness as a means for the distribution of information, and there is some question as to whether it should not be placed first.

[17] E. P. OBERHOLTZER. World's Work 41: 249–263. January, 1921.

There can be no doubt as to the superior appeal of pictures as compared with printed words. When we multiply this superior appeal by the factor of motion, so that events are presented almost as vividly as if the observer were present on the scene; and still have available the factors of repetition at will, physical magnification to bring out details of form, retardation or acceleration of speed to analyze the motions, and finally, accessibility of the whole to a large number of people simultaneously, the possibilities of distribution by film seem almost limitless.

The method is already in wide use for distributing information. Its use as an adjunct to lectures has already been mentioned, but that use is now of secondary importance. The showing of instructional films as part of a program for which people are willing to pay is not uncommon; as to whether it is increasing or not I am not sufficiently well informed to say. Doubtless this feature of the movie program will have its ups and downs as has the informational article in the newspaper and popular magazine.

Its philanthropic use is undoubtedly expanding. Among the Federal bureaus, the Department of Agriculture, the Bureau of Mines, and the Reclamation Service have perhaps made the widest use of the method, having several hundred films available for loan.

I have briefly touched upon some of the salient features of the "pure components" of our methods of distributing information. These may be, and commonly are, combined in various permutations and combinations, which we cannot consider here in detail. I have also indicated certain directions in which each of our distribution methods fails in effectiveness, which brings us to our third question: What of it?

III. THE EVILS OF INEFFECTIVE DISTRIBUTION

The years following 1914 have given an impressive demonstration of the ease with which man may relapse into barbarism, and have set a larger number of persons than usual to thinking on the problem of how best to insure human progress. Although few would publicly dissent from the thesis that to provide for the maximum possible *accessibility* of our nearest possible approximations to truth is a *sine qua non* of progress,[18] yet the survival and frequent approval of

[18] To go further and say that the widest possible *dissemination* is desirable implies a selection of material, since no individual can absorb all that is available; but this leads into the kind of discussion which soon goes aground on the irregular rock bottom of personal prejudices and ethical principles.

such half-truths as "A little learning is a dangerous thing" show that the thesis is by no means universally accepted and acted upon. To argue this question here would be quite fruitless, since I have already shown that the number of persons who will hear and read this address is not only small, but drawn from a circle in which the thesis needs no demonstration. I shall pass on to the more practical question: What are you and I going to do about it?

IV. THE FUTURE OF THE DISTRIBUTION OF SCIENTIFIC INFORMATION

"A responsibility rests upon us to see also that the results of our own investigations are not buried more deeply than were the materials upon which they have been based."[19]

With this general sentiment we all agree. As to its particular application, probably each of us has his individual opinion. That opinion should be based, not on prejudice or on our usual naive assumptions regarding human psychology, but on scientific information, much more accurate and detailed than the crude sample I have just been endeavoring to distribute.

In the following paragraphs I shall take up each of the methods of distribution already discussed, and indicate a few of the possible or probable directions of their future development.

Personal communication.—There is no improvement to be hoped for from this method of distribution. Indeed, as I have hinted before, we need less of it rather than more. If men especially fitted by temperament and training to do original research are employed with the expectation of devoting their whole time to the task of digging out new knowledge, they should not be expected to spend time and energy retailing that knowledge.

I have already referred to complaints by the Government's scientists of the wasting of their time in answering miscellaneous questions. This is not indolence, narrow-minded selfishness, or lack of public spirit on their part, any more than it is selfish for the President of the United States to refuse to give his whole day to receiving visitors; he has other important business to attend to.

Various results follow if the investigator is not protected by the administrative part of his organization against too much questioning. One effect is that he does as much of his research as he can at home, or in some obscure corner where visitors cannot find him; but this inter-

[19] J. C. MERRIAM. *The research spirit in the life of the average man.* Science 52: 473–478. November 19, 1920.

feres with the "team work" necessary to make an *organization* successful, as such. Another effect is to drive him altogether out of public or philanthropic research into industrial research, where it is commonly assumed (whether rightly or wrongly I do not venture to say) that "silence is golden."

The above remarks do not apply, it hardly need be said, to the personal exchange of information among investigators; this is a part of the process of production rather than distribution.

The informational middleman.—Once in a while it happens that an individual who has undertaken to do research finds the personal retailing of information much more to his taste than the slow and tedious and discouraging task of digging it up. He should by all means be given a chance to utilize the talent, with a corresponding release of burdens on the research worker. Some of the Federal bureaus already have what might be called "secretaries for foreign affairs" who stand between the bureau and the public, but I believe their functions could be profitably enlarged; the large proportion of simple and oft-repeated questions which comes to them might be transferred to a central bureau of information representing all the scientific bureaus, which might also handle that most time-consuming of all inquirers, the "harmless crank."

The large research foundations are so new that the public is not yet widely aware of their existence as sources of knowledge, or, when it is aware of them, assumes that they are manufacturing something tangible and salable. As they become better known, however, they will have to provide some organization for answering questions, for they are public institutions in an environment which is relatively unsympathetic, and considers them all too frequently as possible sources of alms but of little else. They cannot afford to overlook any method of enlisting public confidence.

The retailer of information for profit is also likely to increase in numbers in the future. In the field of medicine, for instance, it is now possible to consult the diagnostician who reports facts only and offers no treatment or advice, and this kind of service will increase with the increase in medical specialization. We may even perceive a kind of wholesale and retail system in the course of development, the wholesale distribution being through specialized bureaus by way of technical publications to which the public has little if any access, but which the information office digests and retails to its inquirers. Various commercial information bureaus in Washington, such as that of F. J. Haskin, perform this kind of service.

In general, the most hopeful possibilities for improving the distribution of information lie in the direction of increasing the numbers and improving the training of the informational middleman.

The public lecture.—The philanthropic lecture as now employed is extremely wasteful and inefficient. Lack of cooperation between small organizations frequently causes duplication of a lecture in the same city, both times to small audiences. An invited lecturer will travel long distances over the same railroad to neighboring cities, to an extent that would astonish a Keith-circuit organizer. We can improve this situation by ourselves insisting on the principles that the original investigator, when asked to present his work, be given an opportunity to reach as wide a circle of interested persons as possible; and that after he has thus presented it he be relieved from duty as a mere entertainer, unless he enjoys lecturing and does it for recreation or training.

The presentation of information at general meetings of the scientific societies is capable of improvement in many ways, and has been the subject of considerable experimentation, but I shall not attempt its discussion here.

A recent development which may be of great significance is the distribution of public lectures by wireless telephony.

The museum and exhibition.—I have already referred to the evolution of the modern museum in the direction of becoming much more of a diffusing agency, and less of a collecting, examining, and storing agency. This work will doubtless be extended by the loaning of exhibits and the formation of traveling exhibits. The museum is already combining other agencies, such as lectures, printed bulletins, and moving pictures, with its own particular method of distribution and this expansion may also be expected to continue. It has not yet, as far as I know, seriously attempted to combine with itself anything resembling what I have called the "informational middleman" for the personal retailing of information, except occasionally in connection with special exhibits. This is a development which we may expect in the future.

Books.—The best way to get information on an unfamiliar subject is by a personal interview with somebody who knows, and the next best is to go to the encyclopedia. In either case, one is likely to strike a trail which leads to a specialized book on the subject. If it is a book made and sold for profit, the course is clear. But if the

book is distributed philanthropically, it is much less easy to obtain. Considerable correspondence may ensue to find it, unless the seeker is in a hurry, in which case he engages the services of a book-dealer and pays for the service. If the book has been issued free by a Federal bureau, with the hope that it will reach as many as possible who are interested, it might seem that the Government would welcome such assistance, especially when the consumer is willing to pay for it. Yet the Haskin agency, which distributed 1.3 million government publications in 1918–1919 at no more than the cost of postage, was severely criticized in the Senate by Senator Smoot,[20] and with it the bureaus who permitted themselves to be thus aided. The tendency of the next few years seems likely to be toward restriction rather than enlargement of free Federal distribution.

It goes without saying that the free distribution of books to all involves tremendous waste. Our Federal and State governments have been the most prodigal in the world in this matter. The law requires that reasonable care be exercised to prevent waste but the law is difficult to administer.

An obvious remedy is to sell the publications "at cost." But what is cost? At the end of 1919 the Carnegie Institution of Washington[21] had expended on research 11.9 million dollars, and had published 401 works, with an average edition of about 800, or a total number of volumes of about 327,000. If we assume that half the work of the Institution has been thus published, the cost per volume is about $18.00. As the books could not be sold in any number at this price, the price has been fixed at a figure which will represent the cost of paper, printing, and binding. As a basis for distribution this is admittedly unsatisfactory, for the value of a book cannot be measured either by its total cost of production or by the cost of printing and binding it. Some of the works were sold out long ago; others move but slowly, and diminish in real value the longer they remain in storage.

Any system of distribution for books published philanthropically should recognize the distinction I have endeavored to draw between production and use. Producers of knowledge may well be given the fullest possible access, by personal conference, free or purely nominal-priced books, and every other means of distribution, to the new knowledge in process of being obtained by other producers. To

[20] Congressional Record, April 2, 12, and 22, 1920.

[21] Year Book, 1919.

grant the same privileges to those who are mainly consumers might, as I have indicated before, swamp the whole process of production.

Scientific and technical periodicals.—Concerning much that is published in our voluminous scientific and technical literature we might reasonably ask, as the Mock Turtle did of Alice, "What *is* the use of repeating all that stuff?" If we had an all-wise censor to judge it, we might well dispense with the greater part of it. But in that "if" is contained the whole argument against any kind of suppression.

There is instruction, and perhaps encouragement, in comparing the evolution of scientific periodicals with that of newspapers and popular magazines. The newspapers began with small local circulations at a few places. They increased in numbers, and a few papers forged to the front and became leaders, widely read or quoted from. The multiplication of local papers, however, did not cease, but increased, until now every hamlet has one; their diversification, to represent many groups of people with related interests, went on simultaneously. Of recent years, a strongly marked tendency toward financial and operational centralization has appeared.

Other types of periodical printed matter have gone through a similar evolution, and scientific periodicals are following along in their turn. We have had (1) the period of early growth, and small circulation, but large influence, and (2) the period of greatly increased circulation of recognized leaders, with precarious existence for the smaller members; and we are just entering (3) the period of rapid multiplication of local scientific periodicals together with minute diversification according to specialties. The period of centralization is still below the horizon.

It may be urged that science is universal, and a *local* scientific publication is an anomaly; then so is a *specialized* journal, for knowledge is no more to be divided into compartments according to the temporary interests of human beings than according to their geographical residence. Nevertheless local and specialized newspapers, magazines, and scientific journals multiply in spite of logic. Every group of a few hundred or a few thousand persons with allied interests, whether allied by profession or by geographical location, seems to need its printed organ, and the feelings of librarians are given no consideration whatever. The Washington Academy of Sciences, for example, representing in its own membership and in its affiliated societies nearly 3000 scientific and technical men and women, with

certain joint interests that are local and not divided according to sciences, finds a demand for a journal which shall represent those joint interests in news, society proceedings, and announcements of the research going on in the city, and strives to fill that need; it may not always be perfectly filled but it is there.

As the number of periodicals relentlessly increases, the need for efficient and thorough abstracting and indexing is being more and more felt and provided for. For example, chemistry and a large part of physics is being admirably served by Mr. Crane in *Chemical Abstracts*. Geology and allied sciences are excellently handled by Mr. Nickles in the annual index issued by the U. S. Geological Survey. Indexing and abstracting is a developing art, which should not be left to amateur bungling, but should be turned over to individuals trained and well paid for the work.

The relation of advertising to scientific and technical journals is a matter of especial interest. It is said that any periodical which can attain a circulation of 5000 or more can support itself on advertising. Why should scientific periodicals not make better use of this fact?

I have already mentioned the Chemical Society's experiment with the *Journal of Industrial and Engineering Chemistry*, which returns from its advertising a considerable revenue to the Society. Now there is nothing in this situation to abrogate the old rule that "No man can serve two masters." If the time ever comes when the interests of the Society and the interests of the advertisers come into conflict, the *Journal* either will have to stand by its advertisers or will have to change its character. Naturally, both the advertisers and the Society will seek to avoid occasions which would lead to disagreement; but that is only another way of saying that the advertisers will exert a considerable influence on the policies of the Society, whether they wish to or not.

The situation is further complicated by the existence in the same field of the periodical *Chemical and Metallurgical Engineering*, which is published for profit and not as the organ of any society. It has the advantages over the *Journal of Industrial and Engineering Chemistry* (1) of publication weekly instead of monthly, making its news much fresher and therefore more in demand; (2) of freedom to use its own income for its own purposes, not for carrying another organization on its back. The *Journal*, on the other hand, (1) has the prestige of representing the largest chemical society in the world and

(2) has the first claim on the material presented before that society. In my opinion, the *Journal* now publishes a higher grade of material, but the *Engineering* has been steadily improving. The *Journal* has the larger circulation by about one fifth. Each claims that it has a circulation more profitable to the advertiser than the circulation of its competitor, but on these claims I am not competent to give any opinion.

There is evidently staged here a contest of the social versus the profitable which I, for one, will observe with interest during the coming decade. Meanwhile, without seeking to condemn or approve either side, I believe we shall do well to keep these facts in mind when considering contributing articles to these journals or others similarly situated.

The progress of experiments such as I have described may not improbably result in scientific societies finding it to their advantage to have all their *publishing* done for profit, just as they now have their printing and binding done for profit. Why not turn the whole conduct of their publications over to an organization which makes a business of editing, managing and circulating periodicals, subject of course to some original control by each society as to the general nature of the papers to be published?[22]

One benefit which would result would be the saving of time and energy of investigators now spent on routine editing and publishing. The amount of good research which has been prevented by scientific periodicals would probably be appalling if we could sum it up. Another benefit would be the suppression of a great deal of data now being published simply because space happens to be available but for which there is not and never will be any demand. On the other hand, the work of a Willard Gibbs might also be suppressed.[23]

Another point regarding advertising. We all recognize that the consumer pays for it, yet he has little if any control over what he has paid for. The manufacturer tells him what the manufacturer would like to have him know, and no more. Why should not the consumer have his advertising page, in which to tell the manufac-

[22] An experiment of this kind is about to be tried by the Chemical Society with its two series of Scientific and Technologic Monographs, by contract with the Chemical Catalog Company of New York.

[23] On second thought I find I have selected a bad example. If the *Transactions of the Connecticut Academy* had not been available, Gibbs' work might have been offered and published where it would have really circulated, and the English-speaking world would not have had to wait for it to be translated into German before it could become known.

turer what he wants, and in which to tell his fellow-consumers his experience with what had been offered? The editors of the *Journal of the Washington Academy of Sciences* have considered the feasibility of publishing "consumers' advertising" of this kind, since the Academy, as a private organization with no governmental or commercial affiliations, is in a wholly disinterested position, and furthermore numbers in its membership representatives of almost every ramification of science so that a wide range of experience is available. The task of "advertising manager", to collect, edit, and publish material of this type, however, is one of those public services which are more praised than rewarded.

Newspapers and popular magazines.—The appearance of scientific information in newspapers and popular magazines is relatively so recent that it would be rash to try to predict its future. These media themselves may change considerably during the next two decades. The present tendency toward centralized ownership and management of both types probably bodes good rather than ill for the distribution of information, whatever may be thought of the tendency in its political and social bearings.

Separates.—The use of separates seems to be on the increase, and I believe is destined for continued growth. In particular, their use in place of special series of "bulletins" published by research institutions is a very desirable development. Bulletins issued in independent series are not likely to be effectively distributed, as each has to be handled by itself and librarians are frequently at a loss as to where to index or file them. Their very existence, also, may remain unknown until long after the stock has become exhausted and copies are no longer available for libraries which find them in demand. Articles published in a regularly circulating journal, on the other hand, are not thus lost to view or rendered inaccessible. The difference is the same as that between the privately printed book and the book issued by a publishing house which is always in touch with the channels of distribution.

The distribution of separates by dealers is a service almost lacking in this country. For instance, before the War the surest way to get a separate of an American geological paper was to write to Leipzig for it. Patriotic pride, if nothing else, ought to stir us to remedy this situation. Some authors deliberately send copies of their separates to the second-hand dealers in order better to reach interested persons unknown to them; while others condemn this practise as undignified.

Printed matter in general.—I have reviewed briefly certain phases of the distribution of information by the printed page. There remains another point of view from which to consider all of them.

To distribute information by printing it is necessary first, to place the printed article in the reader's hands; second, to induce him to *read* it, rather than file it or put it in the waste-basket; third, to present the matter so that the reader gets some profit from his reading.

The members of the advertising profession are probably the best fitted to instruct us as to the best way of putting reading matter into peoples' hands, but I do not happen to know of any scientific organization which has actually utilized their experience. The organizations best known to me are experimenting, each with its own system, and the results will after some years be valuable as comparative experiments. Present tendencies in the distribution of free or nominal-priced publications seem to be in the direction of the periodical issuance of lists or announcements of publications to a large mailing-list, the recipient being expected to make his own choice and go to whatever trouble is necessary to obtain the publication. Details of the process vary widely, and the future will see the elimination of the less effective procedures.

The second problem, that of inducing the recipient to begin to read what he has received and perhaps has even personally asked for, calls, in the commercial field, for the highest art of the advertiser. I doubt whether this phase of the question has ever been given much serious consideration by the distributor of scientific information, though it is the very life of modern printed advertising. Certainly the Federal bulletins coming from the Government Printing Office all look alike, and I question whether all of them would be called "attractive" by the commercial printer. I feel that we would do well not to be satisfied with the dictum that "information is information and the consumer may take it or leave it."

The third point, of presenting the matter so that the reader gets something for his pains, is where the investigator himself is put on his mettle. I have presented his complaint against too much questioning, but there is no intention of relieving him from the duty of giving a clear account of his product, *in writing*. The account need not be non-technical or suited for general reading, but it should be understandable with the minimum of effort by the circle of readers for whom it is written. Here is where the investigator most often fails. Dr. George Otis Smith, director of the U. S. Geological Sur-

vey, has made it one of his favorite subjects of discourse to urge that the results of investigation be stated in clear and easily understandable language, and to point out that muddy writing is usually the product of muddy thinking. He provides, for his organization, an editor who gives his whole attention to improving the readability of the Survey's publications. Most organizations have editorial committees, sometimes seeming to ramify ad infinitum, but current discussion and comment lead me to believe that the less of this kind of committee work we can get along with, the better. A more practical system to work toward may be indicated in the fable of the successful publishing house which passed for publication only matter which was found to please the janitor.

If the investigator neglects his plain duty of presenting an accurate and clear account of his results (though not necessarily non-technical or adapted to the use of the public), and his organization neglects its duty of seeing that the account is readable and accessible, then there is little ground for complaint on their part if the work is overlooked and even duplicated by somebody else. Although it is perhaps contrary to existing professional tradition, I feel that "a thorough knowledge of the literature" is not incumbent on an investigator if a part of that literature is so obscure as to require a disproportionate time for its discovery and deciphering.[24]

The "movie" film.—The future of the distribution of scientific information by the "movies" is simply beyond prediction. Perhaps its recent vigorous growth is only that of a mushroom, without permanence. Rapidly increasing investments in the business, on the other hand, indicate considerable confidence in its future. Progressive educators, also, are fully aware of its possibilities, as indicated by the recent formation of a "Society for Visual Education." One thing is certain: that the best results will not be attained by leaving the matter to the ruthless natural selection of commercial competition. Neither will anything serious be accomplished by considering the moving picture as merely an adjunct to the lecture or museum.

Other methods.—A minor method of distribution, used particularly in crystallography, physiology, paleontology, and geography, is that by models or casts made in any desired number from a mold. Its

[24] "It is the worst of educated men that they cannot speak about any great question till they have read everything that has been written about it, for fear that some one should say, 'But have you read Schwartzenburg?' Then, if they have not read Schwartzenburg, they are done."—TOLSTOY.

use could well be extended to other sciences. Phase-rule models in chemistry, for instance, concentrate a great deal of information into a small space and put it into a form very useful for instruction.[25] Another minor method is the distribution of type collections of material, made up in considerable number from a common supply, and distributed usually by sale. This has been used in the fields of mineralogy and petrology and certain branches of biology. Collections of photographs have been similarly used by some of the Federal bureaus. The number and field of usefulness of such reproducible collected sets of material objects is likely to be enlarged.

The general problem of distribution to the public.—I have referred repeatedly to the "bulk" and "heterogeneity" of our present output of scientific information, and hope that by inference as well as by direct statement I have already impressed the idea that haphazard dissemination does not constitute orderly distribution.[26] We have accomplished little if we have merely reached the auditory or optic nerve of the public without reaching its understanding. Have we any assurance, for example, that the Science Service for the newspapers (after performing its obvious and useful duty of preventing misinformation) will do more than merely replace on the newspaper page an equivalent area of advice, gossip, or fun, producing about the same permanent effect as the displaced material? I hope the plans of the Service will include some method of measurement of its permanent results, for, in chemical terms, if there is no solubility there will be no absorption, however large we make the area of contact; and if the absorption turns out to be small we shall have to do something to increase the solubility.[27]

In conclusion, I wish to express my indebtedness to various members of governmental and private institutions in Washington for assistance and suggestions in the preparation of this address.

[25] The Geophysical Laboratory has received a number of requests for copies of its models of silicate systems, but is not equipped to manufacture and sell such a product. Some commercial or philanthropic agency would do a service by taking up this kind of distribution.

[26] *Dissemination:* "Propagation by means of diffusion or dispersion....Propagation by means of promulgation; a spreading abroad for or with acceptance, as of opinions." (Century Dictionary). The disseminator selects what is to be promulgated and the public is at his mercy. *Distribution:* "Allotment in shares or according to requirements.....The division of the aggregate produce of the industry of any society among the individuals who compose it." The public does the selecting and the distributor renders the product accessible.

[27] "One can readily conceive a Dark Ages which was such because of too much instead of too little information." The Villager 4: 94. November 6, 1920.

GENERAL SUMMARY

The production of new information in the United States is much better managed than its distribution. It is distributed through five main channels: (1) by personal communication or through the "informational middleman;" (2) by public lectures; (3) by the museum and public exhibition; (4) by the printed page—books, scientific and technical periodicals, bulletins, general periodicals, newspapers, and separates; (5) by the cinematograph. Ineffective distribution results from (1) disinclination to use new knowledge, a cause not discussed in this paper; (2) the inaccessibility of scientific information, arising from (*a*) the bulky form in which it comes from the producer, (*b*) its heterogeneous character, and (*c*) the arithmetical or psychological limitations peculiar to each method of distribution. The bearings of these various factors on existing methods of distribution, both to producers of information and to the general public, are touched upon, and desirable or probable future developments in each are briefly discussed.

SCIENTIFIC NOTES AND NEWS

A reception was held on January 12, 1921, by the President and officers of the Medical Society of the District of Columbia to the members and friends of the Society, including the members of the ACADEMY and its affiliated societies. The reception was held at the new home of the Medical Society at 1718 M Street, following the dedication of the building.

The Washington Section of the American Institute of Mining and Metallurgical Engineers held a supper and meeting at the Interior Department on Friday, January 14. Dr. H. FOSTER BAIN, the newly appointed director of the Bureau of Mines, lectured on *Mines and mining in the Far East.*

The National Museum has received specimens of various deep-water fishes from Hawaii, which had been killed by the recent lava flow from Mauna Loa. Most of the forms have been found by Dr. D. S. JORDAN to be new, and a report on them will be published by the Smithsonian Institution.

An exhibit of medicinal substances arranged according to their therapeutic effects is being prepared for the Division of Medicine of the National Museum.

Dr. J. M. ALDRICH of the National Museum was elected president of the Entomological Society of America at the Chicago Meeting.

Col. J. M. BIRCH of the British Army, in charge of the agricultural development of the Mosul district of Mesopotamia, has sailed from New York after spending several months studying American agriculture. While in Washington he used the facilities of the Bureau of Plant Industry.

Dr. H. C. BRYANT and Dr. L. H. MILLER, of the University of California, have been spending some time in Washington, and delivered addresses before the Biological Society on January 22, and the Audubon Society on January 26. Doctors Bryant and Miller were nature guides in the Yosemite National Park during the summer of 1920 and organized field trips for the instruction of visitors.

Dr. H. L. SHANTZ has been appointed plant physiologist in charge of Plant Physiological and Fermentation Investigations in the Bureau of Plant Industry. Dr. Shantz returned in September from a year's trip through Africa for the Office of Foreign Seed and Plant Introduction, from which office he is now transferring.

Senator CHARLES S. THOMAS, of Colorado, resigned on January 5 as a Regent of the Smithsonian Institution, and the Vice-President appointed Senator A. O. STANLEY, of Kentucky, to succeed him.

Mr. W. F. WALLIS, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, left Washington on January 9 for Huancayo, Peru, where he will succeed Dr. HARRY M. W. EDMONDS as magnetician-in-charge of the Huancayo Magnetic Observatory upon the conclusion of the latter's two-year assignment. Dr. Edmonds will return about April via San Francisco for duty at Washington.